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Nuclear Explosions and Earthquakes

907N0058C Moscow PRIRODA in Russian
No 12, Dec 89 p 78

[Article by N. G. Gamburtseva, candidate of Physical Mathematical Science, Institute of Earth Physics imeni O. Yu. Shmidt, USSR Academy of Sciences]

[Text] "Could underground nuclear explosions induce earthquakes? Where does the enormous energy released by these explosions go? And how, generally, does the nuclear weapons testing, conducted for more than 30 years by the USA and USSR, affect seismic activity in individual regions and on the globe as a whole?" These questions worry many people. Troubled letters come to institutes, to the Academy of Sciences, and to the Central Committee of the CPSU. The number of letters increased sharply after the earthquake in Armenia. New questions arose. In particular, many are asking if the Spitak earthquake wasn't caused by the nuclear explosion at Novaya Zemlya, conducted three days before the catastrophe.

In the end most of these letters are forwarded to us, at the Institute of Earth Physics. Each letter that a worker at our institute has to answer takes a great deal of manpower and time. Therefore I readily agreed with the suggestion of the "Priroda" editors to answer at least the most frequent questions on the pages of the magazine.

I'll start with the most general question of the possibility of increasing seismic activity as a result of nuclear testing. But before discussing this possibility, it should be said that there is a definite periodicity in a number of earthquakes. It has been noticed by many seismologists at various times and long before nuclear testing began.

The periods, which are being examined by various researchers, vary in length, but on the whole within in each region seismic activity is characterized by alternating maximums and minimums. The fluctuations are so significant that it is impossible to determine changes in seismic activity due to nuclear explosions against this background. And a 30 year time interval, over the course of which nuclear testing is conducted, is evidently insufficient for valid conclusions about their influence on seismic activity.

The next series of questions concerns the possibility of artificially inducing earthquakes with the help of nuclear explosions. In recent years the term "induced" or "stimulated" seismicity has appeared in seismology. This variety of seismicity is caused by the disturbance of tectonic equilibrium in some local regions as a result of human activity: construction of enormous dams, filling of reservoirs, prolonged exploitation of oil and gas fields. It is well known that weak earthquakes occur in these regions. In light of this the question is raised: couldn't a nuclear explosion also become the source of "stimulated" seismicity?

We all know that a strong natural earthquake is usually followed by weaker tremors—aftershocks, which are connected with a region's tectonic instability. Although, in the opinion of many specialists, underground explosions are capable of provoking similar earthquakes, so far no one has succeeded in recording one. In a zone of high seismic activity in the Aleutian islands, a 1 megaton nuclear blast did not induce an earthquake[1]. It is true that in some cases very weak secondary tremors induced by the collapse of the explosion cavity are noticed within the test range during explosions. On the whole it is impossible to consider such explosions as a proper experiment, because almost all test ranges are located in seismically quiet regions.

Now several words about how nuclear explosions have an effect at long range, thousands of kilometers from the center of the explosion. Any underground nuclear explosion is an artificial earthquake. However a nuclear explosion differs from an earthquake in the duration of the seismic wave source—during an explosion it does not exceed a fraction of a second. The stimulation of the seismic wave, as experiments have shown, requires not more than 1-5% of the total energy of the explosion (depending on the composition of the rock in which it is produced). Most of the enormous energy of an underground nuclear explosion is released in the form of residual thermal energy for several tens of meters from the center.

Seismic waves from explosions, as with those from earthquakes, quickly fade with distance from the source. Thus, at a distance of more than 1000 km an explosion of 100 kilotons causes fluctuations in the earth's surface with an amplitude of about 1 micrometer. It is difficult to suppose that such small oscillations could induce an earthquake.

The majority of explosions conducted in the USSR and USA approximate an earthquake of magnitude 5.5 in energy. Dozens of such earthquakes occur every day around the world, while explosions number dozens per year. Moreover, every year around the world 100-160 stronger earthquakes with magnitudes of 6-8 occur. So the share of nuclear explosions in this total is very small.

More: the broadcast and print media often announce information on ordinary earthquakes, which are beyond number. This partly explains the unjustified anxiety among nonprofessionals and creates a false impression about an abrupt activization of the crust.

Footnotes

1. Engdahl, E. R. Bull. Seismol. Soc. America, 1972. Vol. 62, No 6 pp 1411-1423.

UDC 556.314:574.51; UDC 550.343:(550.83+550.84)

Use of Component Analysis in Hydrogeochemical Prediction of Earthquakes

907N0059A Alma-Ata IZVESTIYA AKADEMII NAUK KAZAKHSKOY SSSR: SERIYA GEOLOGICHESKAYA in Russian No 6, Nov-Dec 89 pp 76-81

[Article by K. M. Davletgaliyeva, A. R. Kurmangaliyeva and L. M. Pavlichenko, Hydrogeology and Hydrophysics Institute, Kazakh Academy of Sciences, Alma-Ata]

[Abstract] Research was carried out for developing a method for detecting changes in the hydrogeochemical parameters of ground water preceding and during earthquakes. This involves use of component analysis on an electronic computer, applying multivariate statistics and summation of the main and varimax components. Data were collected from the Nizhnyaya artesian well (2730 m deep) which penetrates into thermomineral waters of Upper Pliocene sandstones. Fifteen indicators were used for characterizing the dynamic and gas-chemical state of water at a definite moment in time: water yield and temperature, pH, EH, content of macro- and microcomponents (Cl, SO_4, Ca, Na, K, F and H_4SiO_4), concentration of dissolved gases (He, Rn) and so-called gas factor. The systematization of these hydrogeochemical data revealed that the sums of the components with their maximal or minimal, but sharply anomalous values

make it possible to predict an earthquake 3 days in advance for events of class 10-11 and 10 days in advance for events with a class greater than 13.7, although much further work must be done in perfecting this method. Figures 2; references: 3 Russian.

UDC 551.588.7

Means of Anthropogenic Change of the Climate

907N0024A Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 9, Sep 89 (manuscript received 27 Dec 88) pp 11-21

[Article by M. I. Budyko, State Institute of Hydrology]

[Abstract] This review of the literature discusses possible scenarios of global warming in response to anthropogenic activity. All works considered expect this warming to exceed that which has occurred throughout the history of man on earth. Detailed information is now available on expected climate changes over most of the Northern Hemisphere. However, insufficient data are available for reliable development of a global energy plan to preserve favorable climatic conditions. That makes it necessary to expand research considerably to verify, supplement and add detail to information on the climate of the future and to provide a solid scientific foundation for plans for the development of economic activity that precludes dangerous changes in the climate of the planet. References 9: 8 Russian, 1 Western.

UDC 551.465.4

Analysis of Rossby Waves in Stratified Ocean

[Article by D. Yu. Lysanov, T. B. Tsybaneva, Institute of Oceanography imeni P. P. Shirshov, USSR Academy of Sciences, Moscow]

[Abstract] The work reported here studies linear Rossby waves in a stratified fluid on a sphere by the asymptotic method of short-wave approximation in a thin layer. It also estimates the range of horizontal scales within which it is necessary to consider the influence of the horizontal component of rotation. The researchers find that the influence of the horizontal component of angular velocity of the rotation of the earth on linear Rossby waves in an ocean of constant depth is significantly stronger in the lower latitudes than in the temperate latitudes. This influence decreases with increasing latitude scale of waves and depends little on longitude scale. This influence is significant in the temperate latitudes for short waves and in the low latitudes for waves of short and moderate length. References 7: 5 Russian, 2 Western.

UDC 551.466.81

Universality and Variety of Background Internal Wave Spectra in the Ocean

[Article by K. V. Konyayev, Institute of Acoustics imeni M. N. Andreyev, Moscow]

[Abstract] Long-term measurements of currents were performed in 1977-1978 in the North Atlantic as a part of the Polymode experiment. In 1975-1980 in the FDRAKE and DRAKE 79 experiments, practially continuous measurements of temperature and current speeds were made in Drake straits. These data are used to determine the slope and level of 104 background internal wave spectra in various parts of the North Atlantic and in the Drake Passage. The background internal waves over a level bottom have a universal spectrum, which can be described by one parameter. The spectrum changes within a primary sequence as a function of depth, wind speed and presence of fronts. As depth increases, the spectrum shifts upward in the sequence toward greater values of p, a dimensionless exponent in the Garret-Mank model of the energy spectrum of horizontal oscillations in internal waves, $F(\omega) = N(z)E_0(\omega/\omega_0)^{-p}$, where $N(z)$ is the buoyancy frequency as a function of depth z, E_0 is the normed spectral density at a frequency of 1 cycle/hour, and $\omega_0 = 1$ cycle/hour. Background waves over an uneven bottom differ qualitatively from those over a level bottom. Individual

deviations are quite great and the form of the spectrum is not universal. Figures 6; references 8 (Western).

UDC 534.26

Correlation of Noise Pulses Reradiated by a Disturbed Surface

[Article by A. V. Nosov, Institute of Oceanography imeni P. P. Shirshov, USSR Academy of Sciences, Moscow]

[Abstract] The researchers describe an experiment aimed at verifying the coefficient defining the interrelationship of noise signals and initial pulse sequences reflected off a disturbed ocean surface. The correlation K is approximately $(\rho/T)^{1/2}$, where ρ is the interval of time-related autocorrelation of the initial noise sequence and T is the typical duration of surface reverberation, is verified by first computing the average reverberation curves and measuring their width at the half-power point. The duration of the tone-filled initial sequence is subtracted from that, and the difference is taken as an estimate of T. The interval of the time-related autocorrelation of the noise signals is defined as the width of the envelope of the coefficient of the autocorrelation at the 0.5 point. After that, the correlation is used to calculate the theoretical value for K (K_T). Experimental and calculated results agree satisfactorily. Figure 1; References 4: 3 Russian, 1 Western.

UDC 551.465

Structural Features of Hydrophysical Characteristics and Internal Waves Near Shelf Boundary

[Article by V. V. Navrotskiy, A. Yu. Lazaryuk and A. A. Malyshev, Pacific Ocean Oceanological Institute, Far Eastern Scientific Center, USSR Academy of Sciences, Vladivostok]

[Abstract] Observations in the Sea of Japan indicate that near the shelf boundary in a seaward direction there is a marked change in the position of the seasonal thermocline which can be regarded as a weak hydraulic jump. Quasiperiodic destruction of the hydraulic jump or other nonlinear effects related to it may lead to the generation and propagation of short and high-frequency internal waves on the shelf. The effect of internal waves on vertical mixing leads to such a restructuring of the density field with which the group velocities of internal waves decrease and the concentration of their energy on the shelf increases. The overall effect of the short internal waves generated near the shelf boundary is an increase in

thickness of the thermocline, forming a fine vertical structure and increasing the intensity of vertical flows, attaining values characteristic for small- scale turbulence in the upper layer. The latter circumstance may explain the quasistationarity of structure of the upper thermocline during prolonged summer periods of positive buoyancy at the upper boundary when there should be a continuous increase in the intensity of the density jump. By ensuring greater transport of heat, oxygen, mineral salts and organic material it is very important for hydrobiological productivity of shelf zones. Figures 4; references: 3 Russian.

UDC 551.466.8

Interaction Between Internal Waves and Region of Horizontal Inhomogeneity of Density Field Stituated Over Ridge

[Article by N. M. Stashchuk and L. V. Cherkesov, Marine Hydrophysics Institute, Ukrainian Academy of Sciences, Sevastopol]

[Abstract] During the propagation of an internal wave (n-th mode with the amplitude A_n) across a frontal zone situated over a ridge this wave is transformed and other modes are generated. A solution is found by the Riemann method for a uniformly stratified ocean. The dependence of the amplitudes of generated internal waves on the parameters of stratification and bottom relief is determined. The amplitudes of the reflected modes are small in comparison with A_n (not more than 20

for the considered range of parameters) and the passing modes may be comparable to A_n for numbers of modes close to (n - 1, n + 1). If the ridge profile is sufficiently steep, in the transition region and behind it wave disturbances of increased intensity may be concentrated in zones of the ray type. An increase in horizontal density in the frontal zone results in a broadening of these zones with a decrease in the maximal intensity in them. Under other conditions an intensification of the intensity of the field of wave velocities is noted only over the ridge. Figures 2; references: 5 Russian.

UDC 551.465

Autooscillations of Oceanic Thermohaline Circulation

[Article by B. A. Kagan, N. B. Maslova and V. V. Sept, Leningrad Section, Oceanology Institute imeni P. P. Shirshov, USSR Academy of Sciences]

[Abstract] Paleontological and other analyses show that the spectrum of paleoclimatic indicators characterizing changes in ice volume and ocean surface temperature contain maxima with a number of different periods in large part consistent with the period of oscillation of eccentricity of the Earth's orbit with a period of about 100 000 years. It is still unclear why oscillations with a period 100 000 years predominate over the other periods. Three plausible explanations have been given, but on closer examination all have shortcomings. In this article it is shown that there is still another explanation for excitation of oscillations with a period close to 100 000 years: autooscillations of thermohaline circulation, having the property that their stability is dependent primarily on allowance for haline factors. This situation is examined in a three-component box model of the climatic system in a hydraulic approximation describing thermohaline circulation in the ocean. The problem is studied using the equations for the budget of heat and salt in the system of equatorial and polar boxes of the ocean and the equation for the budget of mass of glaciers. The results of computations indicate that the autooscillations reproducible by the model have a period 99 700 years. Their amplitude is about 3.5 K for temperature, about 2.2 o/oo for salinity and about 5 m/year for the rate of vertical movements in the ocean. These estimates are close to those documented by the paleontological method. Figure 1; references 12: 1 Russian, 11 Western.

UDC 551.466

Propagation of Airy and Fresnel Internal Waves in Horizontally Inhomogeneous Medium

[Article by V. V. Bulatov and Yu. V. Vladimirov, Problems of Mechanics Institute, USSR Academy of Sciences, Moscow]

[Abstract] The problem of the propagation of Airy and Fresnel internal gravity waves in a stratified medium with a horizontally inhomogeneous density field is solved by the "travelling wave" method, a generalization of the geometrical optics method. A study was made only of the region near the wave front making use of the weak dispersion approximation. It is assumed that the scale of horizontal density change is much greater than the characteristic lengths of the internal waves; no assumption is made concerning slowness in vertical change. The problem is reduced to an eikonal equation, whose solution is given in the article, thereby determining the wave front position. Equations are given for defining the change in wave amplitude; other equations are given for determining evolution of the width of the impulses of the Airy and Fresnel waves. Numerical computations show that when horizontal inhomogeneities of the density field are present there is an appreciable curvature of the

wave fronts and also a change in the width and amplitude of impulses of Airy and Fresnel waves. Figures 2; references 7: 6 Russian, 1 Western.

UDC 532.59

Spatial Instability of Internal Waves in Continuously Stratified Currents

907N0060C Kiev MORSKOY GIDROFIZICHESKIY ZHURNAL in Russian No 6, Nov-Dec 89 (manuscript received 15 Jun 87, after revision 25 Feb 88) pp 19-24

[Article by S. M. Khartiyev, Rostov State University]

[Abstract] A stationary parallel current of a continuously stratified fluid of a constant depth was investigated in order to ascertain the conditions under which internal waves may be unstable. The spatial instability of internal waves was studied on the assumption that the current has only vertical shear velocity. An appropriate boundary value problem is formulated in which the origin of the rectangular coordinate system is at the bottom of the flow and the z axis is directed vertically upward. Various simplifying assumptions are introduced and the equations of hydrodynamics and the boundary conditions are written. It is shown that regardless of the value of the Richardson number there are solutions of the homogeneous boundary value problem which are unstable in space coordinates. With satisfaction of the conditions defined in this article, in addition to internal waves which are stable in time there may be various unstable wave disturbances. References 11: 9 Russian, 2 Western.

UDC 551.456.7

Asymptotic Behavior of Turbulent Mixing Path Near Wave Layer

907N0060D Kiev MORSKOY GIDROFIZICHESKIY ZHURNAL in Russian No 6, Nov-Dec 89 (manuscript received 6 Apr 88) pp 24- 28

[Article by K. L. Yegorov, Leningrad Hydrometeorological Institute, Leningrad]

[Abstract] A study was made of a class of models of the turbulent boundary layer based on the equation for the balance of turbulent energy and with closure using hypotheses of the Karman relations type. It is shown that in the absence of velocity shear near a boundary with a flow of kinetic energy of turbulence all the models can be combined into a unified hypothesis and the linear dependence of the mixing path on increasing distance from the surface is satisfied. Five models are considered and pertinent data are tabulated. The Karman model, in contrast to the other models, gives an increase in the turbulence coefficient with increasing distance from the surface. However, such a result is scarcely admissible in a purely diffusional mode without velocity shear. With respect to the other models considered, the question of the advantage of any one of them can be solved only in

a comparison of computed data with data from in situ observations in the surface layer. However, available data make it possible to judge only the qualitative nature of the behavior of some turbulence characteristics with depth and these data are inadequate for a final solution of this problem. References: 7 Russian.

UDC 551.466.82

Short-Period Internal Waves in Frontal Zones of Tideless Seas (in Example of Black and Aegean Seas)

907N0060E Kiev MORSKOY GIDROFIZICHESKIY ZHURNAL in Russian No 6, Nov-Dec 89 (manuscript received 20 Jul 87, after revision 9 Aug 88) pp 41-47

[Article by Yu. N. Goryachkin, V. A. Ivanov and A. D. Lisichenok, Marine Hydrophysics Institute, Ukrainian Academy of Sciences, Sevastopol]

[Abstract] In the absence of an atmospheric source the level of in situ spectra of short-period internal waves outside the frontal zones of tideless seas lies below the level of the Garrett-Munk spectrum. On the other hand, in frontal zones it exceeds the model level. Such an energy distribution is due to a substantial change in the depth of the pycnocline in the frontal zones, which in turn determines the nature of the change in phase and group velocities. Their decrease in the region of rising of the pycnocline results in an increase in the amplitudes of internal waves. A second important feature is related to the existence of a sloping pycnocline. An anisotropy of wave packets as a result of refraction is observed. In this case the direction of the wave vectors coincides with the direction of rising of the pycnocline in a direction perpendicular to the strike the frontal zone. The energy level of short- period internal waves in the frontal zones of tideless seas is substantially lower than in the ocean. This latter fact is attributable to the absence of a tidal source of generation of short-period internal waves. The most promising method for detailed study of the influence of horizontal density inhomogeneities on the characteristics of gravity internal waves is the use of towed instruments for measuring the parameters of internal waves, making it possible to collect detailed information on the spatial variability of wave parameters and to verify models developed for an ocean with horizontally nonuniform density. Figures 4; references 12: 10 Russian, 2 Western.

UDC 550.383.3(575.1)

Experience in Predicting Strong Earthquake in Fergana Depression From Highly Precise Magnetometric Data

907N0069A Tashkent UZBEKSKIY GEOLOGICHESKIY ZHURNAL in Russian No 5, Sep-Oct 89 (manuscript received 20 Dec 88) pp 25- 28

[Article by M. Yu. Muminov, V. A. Shapiro, K. N. Abdullabekov and G. Yu. Azizov, Seismology Institute, Uzbek Academy of Sciences]

[Abstract] A regional conductivity anomaly has been defined in the Fergana depression. In 1982 a T-observatory was established at Chimion village and around-the-clock observations of variations of the T modulus have been made with interrogation each 10 minutes. The reference station is situated 200 km from Chimion. With the first indicators of an impending event a system of 15 auxiliary magnetometric observation points was organized in the neighborhood of Chimion, falling on two profiles, one intersecting the South Fergana seismogenic zone and the other coinciding with the axial part of this zone. An analysis of data from the network of T-observatories confirmed that an anomaly developed in the Chimion region. On 22 May 1985 this made it possible to predict an approaching earthquake two months prior to the event. The Khamzaabad earthquake (magnitude 4.8) occurred 22 days after the prediction and had an epicenter 70 km to the SE of Chimion. This experience demonstrated that it is possible to monitor the dynamics of the seismic process in this region and the described geomagnetic methods can be used in predicting the time, force and place of an impending earthquake. Figures 2; references: 5 Russian.

Formation of Subsurface Salinity Maximum in Tropical Atlantic

[Article by V. V. Yefimov and P. E. Boguslavskiy, Marine Hydrophysics Institute, Ukrainian Academy of Sciences, Sevastopol]

[Abstract] The reasons for formation and nature of distribution of the subsurface salinity maximum in the western part of the Tropical Atlantic in the northern hemisphere are directly related to the geostrophic dynamics of the layer bounded by the isopycs σ_z 25.0 and 26.0. The initial data were observations made in 1986-1987 under the "Razrezy" ["Sections"] program. Hydrological stations were occupied each 0.5SD in the area between 12°N and 1°S from the coast of South America to the coast of Africa each 1.5° in longitude. Temperature and salinity were measured each 5 m in depth. The observed distribution is described within the framework of the theory of a ventilated thermocline. This mechanism explains the universal formation of the the subsurface salinity maximum over an extensive area in this part of the ocean, although other factors are operative which determine formation of the layer of increased salinity in the upper thermocline, such as a subsurface current of westerly direction. In the eastern half of the Tropical Atlantic, on the other hand, local mechanisms of formation of the subsurface salinity maximum predominate. Figures 4; references 12: 3 Russian, 9 Western.

Estimation of Concentration of Suspended Matter in Sea From Depth of Visibility of White Disk and Spectra of Ascending Radiation

[Article by V. Ye. Shemshura and V. L. Vladimirov, Marine Hydrophysics Institute, Ukrainian Academy of Sciences, Sevastopol]

[Abstract] The possibilities of a numerical evaluation of the concentration of suspended matter are analyzed, first on the basis of relative transparency for more general observation conditions, and second, on the basis of the effective wavelength, being an integral parameter of the entire spectrum of ascending radiation. Various source materials, including observations on the Guinea shelf in the dry and rainy seasons of 1985 and 1986, were used for determining the interrelationship between the concentration of suspended matter (C) and the depth of visibility of a white disk (z_w). A joint study was made of 284 pairs of joint determinations of C and z_w in a broad range of change. Most of the samples were taken in the surface water layer. It was found that there is a linear correlation between the logarithms of C and z_w. The corresponding regression equations, characterized by a correlation coefficient r = -0.97, are given. Formulas are proposed for estimating C on the basis of the spectral composition of the natural light flux ascending from the sea. The derived equations can be used in fast computations of suspended matter on the basis of data from hydrooptical observations, especially in those cases when a high accuracy of the final result is not mandatory. Figures 2; references 12: 9 Russian, 3 Western.

Anomalous Behavior of Metals in Zone of Underwater Gas Source on Paramushir Island (Sea of Okhotsk)

[Article by L. L. Demina and V. B. Atnashev, Oceanology Institute imeni P. P. Shirshov, USSR Academy of Sciences, Moscow; Ural Scientific Research Institute for Multipurpose Use and Conservation of Water Resources, Sverdlovsk]

[Abstract] A study was made of the distribution of Mn, Fe, Cu, Cd, Cr, Co and Ni in sea water (42 samples, dissolved and suspended forms) in the region of outlet of an underwater gas source (discovered in 1982) on the northwestern slope of Paramushir Island. The research was done in 1986 from the "Akademik Mstislav Keldysh" and the "Paysis" submersible. It was found that in the water layer, against a background of a

distribution of elements which is regular for the coastal region, it is possible to discriminate a "column" of increased concentrations of suspended matter, suspended Mn, as well as dissolved Mn, Fe, Cu, Cd, Cr, Co and Ni, spatially coinciding with the propagation of the gas "gusher." This column can be traced up to 780 m from the bottom. The enrichment of water of the main gas "gusher" with metals can be attributed to physico-chemical concentration processes at the phase interface. The source of increased content of metals is evidently the flow of dissolved metals from ooze waters, which is propagated vertically for a considerable distance. Figures 2; references 12: 10 Russian, 2 Western.

UDC 551.583

New Concepts Concerning Bottom Relief in Arctic Ocean

[Article by A. N. Lastochkin and G. D. Naryshkin, Leningrad State University; All-Union Scientific Research Institute of Oceanology, Leningrad]

[Abstract] Data collected during the last decade have made it possible to formulate new concepts concerning structure of bottom relief in the Arctic Basin. In place of the two provinces previously defined (Eurasian Subbasin, Amerasian Subbasin), there is a new province designated the Central Arctic Region of Oceanic Uplifts, separating the other two. It is a complexly structured region, as indicated by a newly compiled orographic diagram of the Arctic Ocean (Fig. 1, 20 types of structures identified) and a map of the largest orographic forms in the Arctic Ocean (Fig. 2, 11 types of structures defined). The greater part of the article is a detailed description of the most important structures within the newly defined region based on the most recently collected materials. Figures 2; references 14: 7 Russian, 7 Western.

UDC 538.3.539.2

Two Models of Local Occurrence of Ferromanganese Nodules on Ocean Floor

[Article by A. V. Bunchuk and M. S. Klyuyev, Acoustics Institute imeni N. N. Andreyev, USSR Academy of Sciences, Moscow]

[Abstract] Two models of the local occurrence of ferromanganese nodules characterized by a different degree of spatial disorder are proposed. This is necessary for experimental and theoretical simulation of sound scattering from fields of ferromanganese nodules. In the first

of these models the positions of the nodules correspond to a cellular disorder and are determined by random deviations from the points of intersection in a regular spatial grid. In the second model the positioning of the nodules conforms to a topological disorder and corresponds to random positioning of solid spheres of different diameters whose centers lie on a plane. The adequacy test for any model is a qualitative agreement between the radial distribution function, computed within the framework of this model, and the corresponding function for the real positioning of the nodules. Figures 5; references 10: 6 Russia, 4 Western.

UDC 551.463

Direct Recording of Temperature Profile in Cold Sea Film During Squall Winds

[Article by G. G. Khundzhua, Ye. G. Andreyev, A. B. Nelepo, A. N. Romanchenko, Moscow State University imeni N. M. Lomonosov]

[Abstract] Direct recording of the temperature profile in the Caspian Sea during squalls (winds 20 m/s and higher) was undertaken in the Summer of 1987, as a means of determining the energy exchange between the sea and the atmosphere under conditions similar to those encountered in tropical cyclones. Recordings were made using a thermal probe floating at a distance of 80-100 m from the ship. Profiles are presented for wind speeds of 10 m/s, 20 m/s and the profile produced by the air blast of a hovering helicopter. Figure 1; References 4: Russian.

UDC 534.222

Formation of Acoustic Signals in New Type of Sound Channel

[Article by B. I. Goncharenko, V. A. Gordiyenko, V. I. Ilichev, academician, A. A. Koropchenko, Pacific Institute of Oceanography, Far-Eastern Division, USSR Academy of Sciences, Vladivostok]

[Abstract] Experiments were performed in November of 1987 over a 500 mile track near a frontal zone. Sound signals at 600 Hz, length 10 minutes, repeated each 15 minutes, were studied using a new type of radiator lowered to a depth of 70-100 m beneath a ship. A combined receiver module consisting of a sound pressure receiver and three-component pressure-gradient receiver were used. Measurement at ranges of up to 200 miles indicate the formation of a new type of sound channel with space-time stability. Figures 4; References 4: Russian.

UDC 911.9:502.7

Change in Global Circulation of Carbon: Le Chatelier Principle in Reaction of Biota to Changing Concentration of Carbon Dioxide in Atmosphere. Report II

[Article by V. G. Gorshkov, K. Ya. Kondratyev, S. G. Sherman, Leningrad]

[Abstract] Continuing an earlier study (IZV. VGO, 1989, Vol 121, No 4), the authors calculate the limits of change of ^{13}C in the atmosphere and examine the transition of the continental biota to an unstable state which does not follow the Le Chatelier principle. The equations presented can be used to determine changes in the carbon cycle based on empirical data, without using models of the structure of the ocean and the continental biota. The use of Le Chatelier's principle allows experimental data to be selected which do not contradict the observed stability of the atmosphere-ocean-biota system. Apparently, the continental biota has been placed in an unstable state which does not follow Le Chatelier's principle and, instead of compensating for distortions in the environment, has itself become a major polluting influence. At present, the less disturbed ocean is performing the function of cleansing the environment. It is emphasized that the loss of equilibrium of the biota— i.e., when the natural biota of the biosphere are replaced by anthropogenic biotic complexes such as agriculture, secondary forests, aquacultures—is of greater environmental danger than its total destruction. Figures 5; references 35: 7 Russian, 28 Western.

UDC 550.388.2

Space-Time Characteristics of Signals Back-Scattered From an Artificially Disturbed Region

[Article by N. V. Bakhmetyeva, N. P. Goncharov, Yu. A. Ignatyev, G. S. Korotina, A. V. Tolmacheva, and P. B. Shavin, Gorkiy Scientific Research Institute of Radio Physics]

[Abstract] Results are presented from a study of the space-time characteristics of artificial medium-scale heterogeneities whose dimensions perpendicular to the geomagnetic field are on the order of hundreds of meters. The characteristics were derived from an analysis of back-scattered signals at 2.7-6 MHz. Measurements were performed in October 1985 and February 1987 with the Sura transmitter operating at 4.785 MHz with effective power of about 50 MW. Radiowaves of standard polarization were emitted to zenith at cycles of 10 seconds to 10 minutes, with intervals between the cycles of 5-10 minutes. Diagnosis was performed from a point about 100 km to the west of the heating unit, with test waves emitted with a wideband horizontal dipole at 2.7-6 MHz in pulse mode. The scattering of the signals was observed at 2.7-2.95 MHz on artificial heterogeneities at 150-160 km. The vertical dimension of the disturbed area occupied by the artificial ionospheric inhomogeneities responsible for the back-scattering at 2.7-4.7 MHz was more than 50-60 km downward from the level of reflection of the powerful radiowave. The horizontal dimensions of the disturbed area responsible for the back-scatter were greater than 80 km, which is twice as large as the size of the ionospheric region illuminated by the antenna system of the heating complex at half-power level. Figures 3; references 7: 6 Russian, 1 Western.

UDC 551.521.31

Method of Determining Short-Wave Radiation Fluxes in Atmosphere

[Article by I.N. Minin, Leningrad State University]

[Abstract] A method of determining hemispherical fluxes of monochromatic solar radiation for problems of short-wave radiation power engineering is described which, unlike the Sobolev-Eddington method of closing the system of two equations in three unknowns with an approximate third relation between two of the system functions, involves a system of two exact relations for ascending and descending fluxes respectively which have been obtained by averaging the equation of radiation transfer over all directions of anisotropic scattering within both upper and lower hemispheres. These two relations are transformed by normalizing the angular intensity distributions to the integral intensity of ascending and descending flux respectively, whereupon the angular characteristics of the radiation field are calculated. An important parameter here is the fraction Γ of solar radiation directly scattered into the upper hemisphere, also diffuse radiation being scattered into it from the other hemisphere. This parameter is a function of the cosine of the incidence angle or, after averaging, of the average cosine for the given hemisphere. The procedure is applied to radiation fluxes passing through an atmosphere with large optical thickness and almost purely dispersive (negligible absorption), the radiation fields within its inner layers thus being almost isotropic. Reflection by the ground surface being disregarded, but can be easily accounted for. The method has already been used for calcu- lating the absorption of solar radiation by the atmosphere of Venus. References 10.

UDC 551.510.534.001.572

Features of Distant Atmospheric Transport of Ozone Over Ocean

[Article by V. M. Bazhanov and A. G. Ryaboshapko, candidates of physical and mathematical sciences, and V. N. Petrov, doctor of physical and mathematical sciences, Applied Geophysics Institute]

[Abstract] A model of the distant transport of ozone over the ocean from a continental source in the lower troposphere is described. The model makes adequately complete allowance for photochemical transformations of gases during transport. It is assumed that the air mass initially contains ozone, nitrogen oxides, hydrocarbons and carbon monoxide in quantities determined by the intensity of anthropogenic and natural sources in the corresponding region. The movement of a given air volume over the ocean is along a trajectory determined by wind direction and speed at 925 gPa. Photochemical reactions transpire in the moving air mass which result in both production and loss of ozone. It is assumed that mixing within the air mass is sufficiently rapid that the distribution of the gases participating in the reactions is homogeneous and that during movement over the ocean there are no new injections of these gases. A temperature inversion occurs virtually everywhere over the ocean and its assumed thickness is 1.5 km. An algorithm for computing the photochemical block of the model is given. A table gives a full listing of the principal processes determining the photochemistry of tropospheric ozone. The model was used in studying a typical case of distant transport of ozone of anthropogenic origin from the northeastern coast of the United States over the Atlantic during summer. The decisive influence of photochemical processes on the concentration of ozone during transport is demonstrated. The results are in good agreement with measurements of near-water ozone concentrations over the North Atlantic. Figure 1; references 24: 7 Russian, 17 Western.

UDC 551.466.31.072:551.510.522

Allowance for Stratification of Near-Water Atmospheric Layer in Parametric Integral Model of Wind Waves

[Article by G. V. Matushevskiy, doctor of physical and mathematical sciences, and L. M. Voronin, candidate of physical and mathematical sciences, State Oceanographic Institute]

[Abstract] On the basis of the results of earlier research a factor is introduced into the right-hand side of the wave energy transfer equation for taking into account stability of the near-water atmospheric layer. The equation, derived in a finite-difference approximation, can be used in computing wave heights in the nonstationary, nonuniform fields of wind waves. Computations for a model "three-layer" case are cited as an example. A model of nonstationary wind waves, taking into account the conditions for stratification of the near-water atmospheric layer, was constructed which makes possible complete representation of the diversity of wave formation processes in nature. The model is applicable in computations and predictions of waves and is particularly effective in the case of low and moderate wind speeds. In the course of model development the correctness of the "intervals" method used earlier on the basis of heuristic considerations was analytically validated. Figures 2; references 12: 8 Russian, 4 Western.

UDC 551.510.534(99)

Reasons for Decrease in Ozone Layer Over Antarctica

[Article by V. A. Zhukov, candidate of physical and mathematical sciences, All-Union Scientific Research Institute for Hydrometeorological Information-World Data Center]

[Abstract] It is postulated that the retention of readily soluble aerosols in the polar stratosphere in winter is attributable to their capture by particles of polar stratospheric clouds. It is probable that with time this mechanism has intensified with the cooling of the antarctic stratosphere and the inevitable accompanying increase in the extent of polar stratospheric clouds. In combination with an increase in the concentration of anthropogenic chlorofluorocarbons in the stratosphere this has resulted in the scales of ozone layer impairments which are currently observed. However, such a concentration of forces exerting an influence on ozone is possible only in Antarctica. This gives hope that reduction of the planetary ozone layer beyond the limits of Antarctica is possible only at a much lesser scale. The absence of ascending movements in the south polar atmosphere during spring is probably evidence of invalidity of the hypothesis of dynamic expulsion of polar ozone, rather than any indication of a lesser dust content of the Antarctic troposphere at some earlier time because the capacity for rapid self-purification of the lower layers of the Antarctic atmosphere is a constant factor. The results obtained in this study are in good agreement with hypotheses on the existence of mechanisms of photochemical destruction and dynamic interlatitudinal redistribution of ozone by planetary waves. There is no evidence of the existence in Antarctica of any mechanism of dynamic expulsion of polar ozone by ascending currents in the intrapolar atmosphere. Figure 1; references 11: 8 Russian, 3 Western.

UDC 538.576.452.1

Distortions of Laser Pulse in Raman Scattering Medium

[Article by V. P. Sadovnikov, G. M. Strelkov and M. F. Shalyayev, Radio Engineering and Electronics Institute, USSR Academy of Sciences, Moscow]

[Abstract] Previous studies have dealt with theoretical investigations of induced Raman scattering of laser beams in atmospheric gases, but specific atmospheric parameters were not considered and no allowance was made for attenuation along the direction of propagation, although this factor must be taken into account. At a 1988 conference the authors demonstrated that during the propagation of a strong laser beam on a near-surface path the induced Raman scattering (IRS) process exerts a substantial influence on the redistribution of pulse power among pulse components. A more thorough study was then made of the influence of the IRS process on the propagation of powerful laser beams on extended horizontal paths passing at altitudes 5 and 20 km above the Earth's surface. A quasioptical approximation was used in the investigation. The IRS process exerts an important influence on energy redistribution between the incident and Stokes components of radiation. The Stokes beam changes its profile along the path and then is rapidly dispersed in space. The IRS effect is intensified with a decrease in wavelength of the incident radiation and attenuates insignificantly on high (up to 20 km) paths. Figures 3; references 10: 9 Russian, 1 Western.

UDC 551.521.3

Determining Aerosol Optical Depth of Scattering From Sky Brightness in Visible Spectral Range

[Article by T. Z. Muldashev, V. Ye. Pavlov and Ya. A. Teyfel, Mathematics and Mechanics Institute, Kazakh Academy of Sciences; Astrophysics Institute imeni Akad. V. G. Fesenkov, Kazakh Academy of Sciences, Alma-Ata]

[Abstract] Solution of many problems in actinometry and atmospheric optics requires routine determination of optical depth and its components caused by pure scattering and absorption of light during daytime. After discriminating the Rayleigh component, its subsequent breakdown into components necessitates drawing upon additional information on atmospheric scattering properties. As a source of the latter it was possible to use observational data on the absolute phase functions for the cloudless sky at the solar almucantar. In this article on the basis of solution of the equation for the transfer of radiant energy an analysis is made of an earlier proposed quite simple method for determining optical depth based on measurements of the brightness phase function. Recommendations on its practical use in the visible spectral range are outlined. The results of a numerical solution of this equation are analyzed in the case of a three-mode particle-size distribution. Approximation formulas are derived which make it possible to determine the optical depth of scattering using data from observations of the absolute brightness phase function with an accuracy adequate for practical purposes. Figures 3; references: 8 Russian.

UDC 551.521.3:535.36

Atmospheric Optical Transfer Function Computations

[Article by Ye. O. Dzhetybayev, T. Z. Muldashev and I. V. Mishin, Mathematics and Mechanics Institute, Kazakh Academy of Sciences; All- Union Scientific-Technical Information Center, Moscow]

[Abstract] The results of testing of computation algorithms for solving the problem of radiation transfer in the atmosphere using models of the real atmosphere are given. The test functions used were those determining the effect of the atmospheric optical transfer operator. Computations of the atmospheric optical transfer functions by the Monte Carlo, spherical harmonics and source functions methods revealed a qualitative agreement of the results. A comparison of the results of computations indicated that in computing the important parameters D, E, A_0, c_0, A and Φ the spherical harmonics method is equal in accuracy to the Monte Carlo and iterations methods but has a considerably greater speed. Figures 4; references 17: 14 Russian, 3 Western.

UDC 535.4

Light Diffraction on Plane Thin Screen With Linear Edge

[Article by Yu. I. Terentyev, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] Fresnel attributed diffraction from a screen to the interference of waves reflected from its edge. Discrepancies were explained on the assumption that rays reflected by the screen's edge experience a phase shift close to π. Fresnel, doubting his own conclusion, later explained the diffraction phenomenon on the basis of a combination of the Huygens principle and the interference of oscillations principle. Junge and Sommerfeld

made contributions which only further obscured this matter. The entire problem is reexamined in this article. The existence of a phase shift by π between the edge wave components is experimentally confirmed. It was found that there is an inversely proportional dependence of the amplitude of the edge wave on the angle of deviation of diffracted rays in the case of light diffraction on a thin linear screen. It is shown that the edge wave has an outrunning phase shift of 0.69π on the illuminated side and a phase delay of 0.31π on the shaded side relative to the incident wave. Figures 4; references 6: 4 Russian, 2 Western.

UDC 551.593

Research on Variations of Spectral Attenuation of Direct Solar Radiation Using Measurements in Visible Spectral Range

[Article by Ye. G. Golovina, L. A. Sokolova and A. V. Shashkin, Leningrad Hydrometeorological Institute]

[Abstract] A surface multichannel prism spectrometer was developed for research on spectral optical depth of the atmosphere under unstable conditions. The instrument is capable of making simultaneous spectral readings in 15 channels in the range from 402 to 766 nm, making it possible to obtain the instantaneous values of spectral optical depth. The technical specifications of this instrument are given and the optical system, as well as the electronic components, are represented in diagrams which serve as a basis for a textual description. The minimal time interval between measurements is 1 s. The method for evaluating the variability of atmospheric optical depth on the basis of measurements of direct solar radiation is outlined in detail. The results of a series of measurements of the attenuation of direct solar radiation by translucent cloud cover of different types are presented. Such observations make it possible to detect the spectral variation of atmospheric optical depth characteristic for different types of optical weather. Figures 6: references 11: 9 Russian, 2 Western.

UDC 621.373.826

Thermal Self-Effect of Laser Beams on Inhomogeneous Paths in Turbulent Atmosphere

[Article by V. A. Banakh, N. N. Kerkis and I. N. Smalikho, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] The influence of turbulence on the distribution of mean intensity of a partially coherent laser beam propagating in the atmosphere with a thermal self-effect
on vertical and slant paths is investigated. Formulas are derived which make it possible to find the size and displacement of a beam on any path x greater than x_{eff} on the basis of a set of functions at the boundary of the effective layer of the atmosphere x_{eff}. This can be done by making direct computations of the mean intensity distribution. It is shown that under the worst light propagation conditions it is necessary to take into account the influence of turbulence on the distribution of mean beam intensity even for vertical propagation paths in both the visible and IR spectral regions. Nonlinearity and turbulence make a nonadditive contribution to beam broadening. With a decrease in laser wavelength there may be a substantial increase in the effective beam radius due to turbulence on vertical paths for both the worst and for average light propagation conditions. Figures 4; references: 14 Russian.

UDC 621.378

Nonlinear Propagation of Short Optical Radiation Pulses in Solid Aerosol

[Article by D. S. Bobuchenko and V. K. Pustovalov, Belorussian Polytechnic Institute, Minsk]

[Abstract] In an earlier study (INT. J. HEAT MASS TRANSFER, Pergamon Press, Vol 32, p 3, 1989) the authors gave an analysis of the heating, fusion and evaporation of a single metallic aerosol particle in a gas under the influence of strong radiation under conditions of diffusional-convective heat and mass exchange with allowance for the real dependence of thermophysical and optical parameters, transfer coefficients, etc. on temperature. Work along these lines has continued with a theoretical study of the nonlinear propagation of short optical radiation pulses in a metallic aerosol with characteristic radii of the particles about 1-10 μm on the basis of the mentioned model for a single particle. The investigated particles were in an inert gas, so that oxidation, ignition and combustion processes can be neglected. Allowance is made for the formation of nonstationary, noninteracting heat and mass aureoles around the evaporating aerosol particles scattering radiation. A number of such experiments are examined in detail. Figures 4; references 12: 11 Russian, 1 Western.

UDC 621.378.326

Dynamic Algorithms for Compensating Nonstationary Wind Refraction

[Article by F. Yu. Kanev and S. S. Chesnokov, Moscow State University imeni M. V. Lomonosov]

[Abstract] A numerical study was made of adaptive focusing of strong light beams propagating under conditions of nonstationary wind refraction. The influence of stabilization processes in the temperature field in the beam channel on the effectiveness of correction was analyzed and the limiting time of optimization of focusing, based on both steady and unsteady beam parameters in the observation plane, was estimated. Information is given on the model of the adaptive system used, transient processes in the "beam-medium" system, stability of control, speed of aperture sounding and speed of phase conjugation. It is shown that the dynamic equation for the phase of light beams makes possible a considerable decrease in the optimization time for focusing in adaptive aperture sounding and phase conjugation systems. However, the effectiveness of the control algorithms is extremely sensitive to the length of the gradient interval, which for regular propagation conditions can be determined, for example, from the results of a numerical experiment. Methods are proposed for reducing optimization time. Figures 2; references: 8 Russian.

UDC 621.373.826

Research on Intraresonator Method for Measuring Atmospheric Transparency in Region 10 m on Natural Paths

[Article by S. D. Burakov, A. P. Godlevskiy and S. A. Ostanin, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences, Tomsk; Optika Special Design Bureau for Scientific Instrument Making, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] The results of measurement of the extinction coefficient on an atmospheric path using apparatus based on a laser with a long resonator (CO_2 laser with a remote reflector at the end of the path) in the region 10 μm are given. The work represents a continuation of earlier studies by these same authors. The objective of this continued research was a determination of the absolute values of the registered extinction coefficients and broadening of the measurement range to great optical depths. A block diagram of the optical apparatus used is described. It is shown that the use of an additional mirror in the resonator makes it possible to broaden the range of measured extinction coefficients to values about 50 km^{-1}. Estimates of the dispersion of intensity fluctuations of laser radiation with two- and three-mirror resonators are given. Figures 4; references: 7 Russian.

UDC 528.77:550.814

Optical Methods for Geological Interpretation of Aerospace Images

[Article by A. I. Petrov and D. A. Yanutsh, All-Union Geological Scientific Research Institute]

[Abstract] The theoretical premises of spectral spatial frequency analysis (SSFA) and other optical methods used in a geological interpretation of aerospace images are examined, as well as different instruments used in conjunction with these methods. Various coherent optical and optoelectronic systems suitable for these purposes are discussed, but these have been rarely used because they have been fabricated in only small numbers. It is shown that SSFA can be used with such images and instruments in solving a wide range of problems in structural geology. Examples are given of application of this method in a kinematic classification of different types of faults. The described methods are implemented using, for example, the "Kristall" spatial light modulator and the "Spektr" optical system, both of which are described in detail. These examples indicate that highly effective optical methods will result in much progress in the time-consuming and large-scale process of geological interpretation of aerospace images. Figures 4; references: 5 Russian.

UDC 681.3.06:/550.831-550.838/(26)

Processing of Marine Shipboard Gravimagnetic Measurements by Shipboard and Shore Computation Centers

[Article by I. A. Zhuravlev, S. V. Yakovlev and Yu. K. Astafyev, Dnepropetrovsk Mining Institute imeni Artem]

[Abstract] On the basis of an analysis of the methods used in marine shipboard gravimetric measurements and the volume of data accessible in different survey stages it is shown that it is necessary to process these measurements at shipboard and shore computation centers in three stages. The organization and implementation of computation work during each of these different processing stages are discussed in detail, as well as the structure and functional capabilities of the software (FORD, GRAVIMAG, CORRECT1, CORRECT2, INTERSEC, written in FORTRAN and ASSEMBLER) which has been developed for the processing of these measurements. Such work is essential for more efficient analysis of the gravimetric work done in conjunction with exploration for oil and gas on the shelves. References: 9 Russian.

Analysis of Errors in Measuring Displacement of Center of Solar Radio Emission (DCSRE) Caused by Nonuniform Emission and Absorption by Earth's Atmosphere and Atmospheric Refraction

[Article by A. Kurbanov and V. A. Krylov, Order of Red Banner of Labor Astrophysics Institute, Tajik Academy of Sciences]

[Abstract] When measuring displacement of the center of solar radio emission errors arise which are caused by nonuniform atmospheric emission and absorption, as well as atmospheric refraction. The total vector of these errors is directed vertically to the zenith. Cloud cover on the path of radio wave propagation redistributes the contributions to the total error caused by all atmospheric components but does not change the direction of the total vector of errors. This article contains four sections: 1. Evaluation of error arising due to absorption by the atmosphere. 2. Evaluation of error due to nonuniform atmospheric emission in the main lobe of the antenna directional diagram. 3. Contribution of emission of upper and lower half-spaces outside the main lobe. 4. Error due to refraction. A general expression is then written for the total error. This total error consists of linear and nonlinear terms. The first is attributable to emission through the main lobe of the directional diagram and the second is attributable to atmospheric and terrestrial emission passing through the side and rear lobes of the directional diagram. Figures 3; references: 4 Russian.

UDC 551.521.31

Spectral and Angular Dependence of Second Stokes Parameter in Cloudless Atmosphere

[Article by G. P. Bazalitskaya and G. Sh. Livshits, Kazakh Pedagogic Institute]

[Abstract] The second Stokes parameter of scattered light has not been studied adequately. It is unknown to what degree its value is influenced by multiple scattering. There are no data on the angular and spectral dependencies of the second Stokes parameter for aerosol Q_a and single Q_1 scattering. In particular, it is unclear where the maxima and minima of the parameter Q_{sky} are situated in the daytime sky and what the character of its drift may be with a change in optical conditions and wavelength. This article gives the results of computations and measurements of the second Stokes parameter in a cloudless atmosphere and its aerosol and single- scattering components. The positions of the extrema of the second Stokes parameters, their angular and spectral dependencies, are found for different optical parameters. It is shown that with an angular distance from the sun of 40° the Stokes parameter, with allowance for multiple effects, differs from that for single scattering by not more than 10%. A regression equation was obtained: Q_{sky} (40°), τ_1. This affords a possibility for determining the optical depth of the cloudless atmosphere from space on the basis of polarization measurements of the second Stokes parameter. Figures 2; references 8: 7 Russian, 1 Western.

UDC 551.465

Research on Mesostructure of Oceanic Hydrophysical Fields

[Article by A. S. Monin, R. V. Ozmidov and V. T. Paka, Oceanology Institute, USSR Academy of Sciences]

[Abstract] The use of a new method for measuring the hydrophysical characteristics of the ocean, scanning with a CTD probe while the ship is proceeding on course, has made it possible to obtain extended sections of the temperature, salinity and density of water with a horizontal resolution of about 1 mile. Measurements by the scanning method were made on the 13th cruise of the "Akademik Mstislav Keldysh" (1987): in the neighborhood of the Antilles-Guiana Current, at the equator, in the zone of the Canaries upwelling, in the Mediterranean Sea and in the neighborhood of Ampere Seamount. The investigated areas were characterized by extremely different hydrometeorological conditions: in a zone of relatively weak currents near a region of contact of waters with different T-, S- characteristics, in a zone of strong jet currents near the equator, in a zone of deep convection and in a zone of considerable influence of bottom relief. In all five test ranges qualitatively similar mesostructural inhomogeneities were discovered in the main thermocline. In all these regions there were mesostructural features having the form of "domes," "pits," "jets" or "drops" with vertical dimensions of about 100 m and horizontal dimensions of about 10 km. Some of the mechanisms leading to the appearance of such mesoscale structures are discussed. Figures 8; references 6: 5 Russian, 1 Western.

Satellite-Borne Multisensor System Developed

[Article by V. Bibikov: "'Gemma' in Orbit"]

[Text] Belorussian scientists were among the first to develop instruments for studying the Earth's surface from space by spectral methods. And now a qualitatively

new forward step along this route has been taken. The other day an interactive microprocessor spectropolarimetric system, the "Gemma-2 video," was delivered to the "Mir" space complex by the "Kvant-2" research module. The cosmonaut A. A. Serebrov told about this from orbit: "We have aboard a new instrument for registry of spectral images of the Earth's surface. Soon we should put it in operation. Information from this instrument is awaited by agricultural and forestry specialists, geologists, oceanologists and fishermen. Its use should yield much of advantage to these branches."

Such an innovation, necessary for science and practical work, was developed at the Scientific Research Institute for Applied Physical Problems and at a special design-technological bureau with experimental production at Belorussian State University in subdivisions belonging to the Scientific Center for Aerospace Detection of the Earth's Natural Resources with the participation of the Energiya Scientific Production Association.

"The initiators in developing the 'Gemma' apparatus were the cosmonauts V. I. Sevastyanov and A. A. Serebrov," explains B. I. Belyayev, deputy director of the center. "They proposed the possibility of simultaneous registry of spectral and spatial information in a single system with the possibility of its analysis and processing directly aboard an orbital complex. This 'grain,' as they say, fell on fertile soil because we had the necessary groundwork of scientific and technical solutions. As a result, an apparatus was developed under the scientific direction of L. I. Kiselevskiy, Academician, Belorussian Academy of Sciences, rector of Belorussian State University, making possible simultaneous registry of five of the six existing optical field parameters. Reference is to the spectral, energy, spatial, polarization and angular characteristics."

The Belorussian scientists have spent many years on the road into space. One modification of the instrument was replaced by another, its optical part was gradually improved and the electronic components became increasingly "intellectual." The fact that this apparatus is at the very forefront of world science is eloquently indicated by the results of an international experiment carried out last summer in the United States with the participation of American, Soviet, French, Canadian and British scientists. The "Gemma" was carried aloft in the same helicopter with an American system having a similar purpose: observations of the Earth were made simultaneously. The possibilities of the Belorussian apparatus were so high that the American specialists exhibited the most lively attention to it.

"The 'Gemma' differs in that it is capable of processing the collected information autonomously and at a real time scale, which considerably increases the efficiency of the researcher's work," continues B. I. Belyayev. "Recently we exchanged the final results of the experiment with the Americans. We assume that in 1991 we will jointly carry out still another experiment, this time in the Soviet Union."

But a still more perfect system has been directed to the "Mir" orbital station. Almost to the last day prior to launching it was subjected to intensive checking on the ground. It was used, in particular, for carrying out research on pollution of the Caspian Sea with petroleum and observations of effluent into the atmosphere from the largest thermal electric power plant in Minsk, TETs-4, and aerial research was carried out on the unique system of Narochansk lakes. Finally, research using the "Gemma" over territories in which potassium salts are being produced in the Soligorsk region made possible a new look at the possible consequences. The conclusions drawn on the basis of such observations served as a basis for recommendations which the scientists directed into space together with the apparatus.

"The ecological aspect in observations from space has an obvious priority," says B. I. Belyayev in completing the discussion. "Such observations make possible a broadening of our knowledge of the course of pollution of the atmosphere, waters of rivers, seas and oceans and on how industrial effluent exerts an influence on the territory around large cities. For the first time the possibility has appeared for routine transmission of information concerning this from space to the Earth and from here our corrections can be sent to cosmonauts. This direction will also be developed further. Even now we are developing the next 'Gemma' with increased resolutions, specialized for ecological research."

UDC 551.509.322

Computation of Wind Fields From Atmospheric Pressure Fields Over Sea

[Brochure by V. I. Makova, candidate of physical and mathematical sciences, All-Union Scientific Research Institute of Hydrometeorological Information-World Data Center, entitled "Computation of Wind Fields From Atmospheric Pressure Fields Over Sea," 54 pages, 395 copies]

[Abstract] This brochure describes and gives a critical analysis of methods for computing the wind field over the sea from the fields of atmospheric pressure developed in the Soviet Union and abroad. The following methods are examined: Sorkina, Cavalery-Bergamin, Strekalov- Volpyan-Krivitskiy, Britton, Veselov, Lanfredi-Freminnon, Hasse-Wagner, Park-Kim, Tokuhiro Wada, Lavrov, Abuzyarov, Overland, Golodko- Radekevich, Bokov-Chvertkin, and Takeuchi-Takada. A new wind computation method is proposed by means of a generalization and modification of some of the considered methods. The wind field in the Sea of Okhotsk is computed as an example. The considered methods are evaluated and recommendations are given on the choice

of the optimal method. In particular, the author's so-called combined method can be used for all hydrometeorological situations in the case of a stationary process when speed is required. The Sorkina method can be used with wind speeds up to 25 m/s in the case of a neutral and unstably stratified atmosphere. The Strekalov-Volpyan-Kravitskiy method makes it possible to take the sea surface roughness parameter into account and can be used for all wind speeds and atmospheric parameters other than a highly stable atmosphere. The Veselov method can be used in wind prediction. The Takeuchi and Takada method can be used in correcting the computed wind on the basis of the measured wind. Figures 12; references 52: 36 Russian, 16 Western.

Ozone-Layer Studies in Moscow Called Publicity Gesture

18650224A Moscow IZVESTIYA in Russian
7 Jan 90 p 1

[Article by V. Belikov]

[Excerpt] A single-seat, high-altitude M-17 airplane was about to begin a flight into the stratosphere.* This airplane bears on its fuselage the names of sponsors and organizers of an experiment: the scientific production association "Noosphere", the publishing department of the Moscow patriarchate, and the Experimental Machine-Building Plant imeni Myasishchev. Before the flight, journalists were told that its purpose was to ascertain whether an ozone 'sieve' has developed over Moscow.

IZVESTIYA's correspondent met with V. Zakharov, deputy chairman of the USSR State Committee on Hydrometeorology, and A. Chernikov, director of the Central Aerological Observatory, who were requested to explain the situation with regard to the state of the atmosphere over the capital.

"During the last days of 1989, the content of ozone decreased by an amount which was very insignificant as compared with the normal level," said A. Chernikov. "Such deviations are within the limits of natural variability. They are connected with large-scale meteorological phenomena: cyclones, tropical storms and other disturbances which occur naturally in the atmosphere."

"Does this mean that the specially equipped laboratory airplane is not needed at all?"

"The airplane is intended for other purposes. Dynamics of the action on ozone of various substances that destroy it will be studied and samples of air and gases will be delivered with the aid of this aircraft. It still has to be equipped with a set of seven unique instruments. Only one of them is installed on the M-17 at present, which renders unplanned flights practically worthless. This is, rather, an advertising measure; moreover, it is being conducted without the participation of specialists."

"We are ready to furnish information and maps which we have for the purpose of notifying the public on a regular basis," said V. Zakharov. "We have also invited the organizers of the M-17 flight to cooperate, but they have turned down our offers so far. They expect to manage with their own forces and capabilities." * See also the Daily SNAP, January 17, 1990, p 3, col 1 (SNAP 900123)

Equipment of Proposed System for Monitoring Environment From Space

18650224B Moscow IZVESTIYA in Russian
3 Jan 90 p 3

[Article by B. Konovalov, science commentator (interviewer)]

[Abstract] The article is an interview with academician Nikolay Nikolayevich Sheremetyevskiy, a general designer. Sheremetyevskiy, who is identified as the head of a project on development of Soviet Earth satellites for meteorology and natural-resources studies, discusses prospects for organizing a permanent satellite-aided system for ecological monitoring on a global scale. Changes in the environment resulting from both natural and anthropogenic factors could be monitored by means of such a system, according to Sheremetyevskiy. It could be used for detecting earthquakes, volcanic eruptions and major landslides and mudslides and tracing their development; detecting smoke from forest fires; recording large discharges of harmful substances resulting from industrial and transportation accidents; identifying and studying accidents at chemical plants and nuclear power stations; and studying the condition of the ozone layer, for example.

Sheremetyevskiy reports that the United States, France and Japan are independently developing systems for monitoring the environment from space, and that a two-tiered system employing new-generation spacecraft is under development in the USSR. The Soviet system is intended for both natural-resources studies and hydrometeorological purposes. Flight testing of spacecraft for this system has begun. They will include "Meteor-3" and "Resurs-0" satellites in low orbits. A meteorological spacecraft in a high geostationary orbit will be the 'core' of the system. Unlike its foreign counterparts, this spacecraft will have good triaxial orientation for more precise geographical fixation of information. Plans call for putting the meteorological spacecraft into operation in 1991, and for the rest of the system to be commissioned in 1992-1993.

Sheremetyevskiy mentions steps which are being taken to organize international cooperation in this area. Agreements with NASA's Goddard Center and France's National Center for Space Research are being prepared, in particular. Instruments for mapping the ozone layer and obtaining data on the earth's radiation balance are to be installed on a spacecraft of the "Meteor-3" type under the terms of this agreement. Sheremetyevskiy is in favor of combining national systems into a global ecological system along the lines of the KOSPAS-SARSAT system for recording distress signals from airplanes and seagoing ships. This ecological system would include a large number of ground stations with special sensing devices for gathering information on emergencies. This would make it possible to assess the seismic state of the earth and to measure and evaluate chemical parameters of the atmosphere and water, for example. Regional and national information-receiving posts could be developed on the basis of common software and uniform data-processing equipment, in line with a unified plan. Sheremetyevskiy suggests that such a plan be drafted under the auspices of a suitable, non-governmental international organization and that the United Nations Organization sponsor this project.

(SNAP 900119)

Earthquake-Forecasting Research at Astrophysics Institute

[Article by I. Saidova]

[Excerpt] Scientists from many countries and from cities of our country gathered recently in Dushanbe for a symposium on problems of middle-atmosphere studies. Yes, the part of the atmosphere in which the ozone holes form, which are now frightening and alarming mankind.

The complex of experimental units for the remote probing of the atmosphere, which are installed at the Gissar Observatory, contributes to the study of the cause of the appearance of these ill-fated holes, but not only of them.

For some time now, earthquake prediction is being discussed at the Tadzhik Academy of Sciences' Institute of Astrophysics. It turns out that the behavior of the ionosphere, its deviations from the norm, can help man prepare for this dangerous natural phenomenon. Two days before an earthquake, the behavior of the ionosphere changes, with the appearance of strong electrostatic fields. More accurate local data can be obtained also from its lower layer, which is located 100-130 kilometers above the Earth.

Thus far, three candidates of physical-mathematical sciences are working on this very topical and vitally important matter—Lev Rubtsov, head of the ionospheric department and the institute's deputy director in charge of science, Obid Alimov and Aleksandr Blokhin. In two years, only the first steps have been taken.

Let us hope that astrophysicists together with seismologists will be able to warn us about imminent earthquakes after all. An automated system for the processing of ionospheric observations is now already in operation at the observatory.

(SNAP 900131)

UDC 911.3:529'711

Macroextrapolation of Sandy Desert Terrain Image Interpreting Characteristics From Aerial Radar Images

[Article by A. K. Monakhov, Leningrad]

[Abstract] A study is made of the possibility of using radar images rather than aerial photographs for extrapolation of natural terrain image characteristics. Studies were performed in two regions of sandy desert in Kazakhstan—the area west of the Karatal River (Taldy-Kurgan Oblast) and the Northern Caspian area (Guryev Oblast). The interpreting characteristics were studied in the first region and then extrapolated into the second using 1:100,000 scale images produced with a horizontally polarized side-looking radar. The use of the radar images allowed extrapolation of image-interpreting characteristics over a range of more than 2,000 km, revealing areas with similar engineering-geological features. Comparison with aerial photos of the same scale showed that radar images are preferable for extrapolating the features of images of sandy plains with solonchak soils, because photographs, unlike the radar images, are quite variegated in places, and solonchak sands are poorly distinguished from blowing sand, particularly in areas with deflation. Figures 2; references 3: (Russian).

UDC 551.510.41:551.510.522(262.5)

Ozone, Chlorine, Hydrogen Sulfide and Sulfur Dioxide in Surface Layer of Atmosphere Above Black Sea

[Article by B. F. Andryushchenko and Candidate of Chemical Sciences A. I. Ryabinin, Sevastopol Department, State Institute of Oceanography]

[Abstract] Air samples were taken 2-4 m above the surface of the Black Sea in 1985-1987 and were analyzed for O_3, Cl_2, H_2S and SO_2. The analysis was done with the Atmosfera-1 and -2 gas analyzers. Concentrations were found to vary widely over the study period. The lowest O_3 concentrations during the winter were observed 5-12 January (1987), when they were no higher than 20 $\mu g/m^3$, probably because of lower air pressure, cloudy weather, winds to the southwest, and temperatures between -4.1°C and 4.9°C. Summer concentrations were typically elevated for the eastern part of the sea. Diurnal variations consisted of a drop in concentration that ended between 12 noon and 3 PM, with a marked increase between 6 PM and 9 PM. The researchers hypothesized that the diurnal variation in O_3 distribution is, to some extent, a function of the chemical composition of the surface layer of water, and the natural variations in O_3 concentration may also be disturbed by air masses originating on land. Cl_2 content (average concentration, 49 $\mu g/m^3$) showed a diurnal variation that was in antiphase with that of O_3, which can be explained by the less intense uptake of Cl_2 from the water. High Cl_2 concentrations are thought to be the result of anthropogenic activity. Average SO_2 concentrations were marked at 32 $\mu g/m^3$, whereas those of H_2S were 11 $\mu g/m^3$. Figures 2; References 3 (Russian).

Stratospheric Ozone—A Modern Problem (Review)

[Article by S. I. Avdyushin and A. D. Danilov, Institute
of Applied Geophysics; State Committee on Hydrome-
teorology]

[Abstract] A review is presented of recent, primarily
American research on trends in total global ozone con-
centrations and on the morphology and physics of the
depletion noted every spring in the ozone levels above
the Antarctic. Total ozone concentration has decreased
over the past decade by a few percent, but it cannot yet
be stated absolutely that this is a response of the strato-
sphere to anthropogenic pollution. Other sources are
possible, such as variations in solar radiation flux. The
October-November Antarctic ozone hole that has been
reported in the past few years obviously results from an
increase in the concentration of chlorine-containing
compounds and from the features of the meteorological
situation during Antarctic spring. Data collected in 1988
and 1989 suggest that, although high concentrations of
chlorine-containing compounds are a necessary condi-
tion for local depletions of ozone, they cannot yet be
clearly labelled sufficient for creating the hole in the
ozone layer, a phenomenon in which dynamic atmo-
spheric processes play an important role. The researchers
suggest that the hole in the ozone layer is, for now, more
precisely described as nature's answer to the question of
whether human activity can have a marked influence on
stratospheric ozone. Figures 4; References 43: 3 Russian,
40 Western.

Refinement of Semiempirical Model of Ionosphere Using Energy Characteristics of Oblique Sounding Signals

[Article by T. P. Zimnyukhova, M. K. Ivelskaya, V. I.
Sazhin, V. Ye. Sukhodolskaya, V. Ye. Unuchkov,
Irkutsk State University]

[Abstract] A study is made of the possibility of refining
the model of the lower ionosphere on the basis of
measurements of energy characteristics of oblique
sounding signals reflected by the *E, F1*, and *F2* layers of
the ionosphere in the context of the A3 method
advanced by Galkin et al. Ivelskaya's semiempirical
model of the ionosphere is used in which elevations,
trajectories, and MUFs of several transmission paths are
calculated and shown to be in satisfactory agreement
with experimental data. The model uses a hybrid prin-
ciple for constructing the $N(h)$ profile that makes it
possible to determine the shape of the profile at altitudes
of 100-150 km by means of solving continuity equations
for ions of atomic oxygen O^+ and molecular ions M^+,
with correction of the parameters of the equations based
on empirical data for f_0E, f_0F2, and h_pF2. The $N(h)$
profile takes the form of two exponential curves with a
boundary between them at 65 km altitude. The
researchers conclude that a more accurate description of
the $N(h)$ profile given by applied ionospheric models at
altitudes below 90 km is needed to compute signal
energy characteristics. They show that data on signal
field intensity along a path with multimode propagation
can be used to refine models of ionospheric electron
concentration. For Ivelskaya's model of the atmosphere,
the efficiency of describing experimental data can be
raised by changing the coefficient with the curve that
describes electron concentration at altitudes coinciding
with the beginning of the ionosphere. For the Kha-
barovsk-Irkutsk transmission path, the value $N_0 = 2$
cm^{-3}, which defines the concentration at $h = 40$ km,
makes it possible to reduce the average difference of
measured and calculated amplitudes from 17 dB to
almost 0. The rms deviation was reduced threefold and
was comparable with the error associated with the exper-
imental data (approximately 6-10 dB). Figure 1; refer-
ences 19: 18 Russian, 1 Western.

Determining Overall Effect of Automobile Traffic on Environment

[Article by N. V. Sorokovikova, Soil Science and Photo-
synthesis Institute, USSR Academy of Sciences]

[Abstract] Materials from the Upper Oka Basin were
used in an overall evaluation of the various effects of
automobile traffic on the environment (a drainage basin
is regarded as the best natural unit for such an evalua-
tion). Factor analysis is used in determining the intensity
of the transport load and its other key parameters. The
basin is broken down into a large number of areal units
in which different conditions prevail. This makes it
possible to define specific areas requiring the most
immediate remedial action, to plan different environ-
mental protection measures for areas in which damage
has been manifested to different degrees. Various pro-
posals are made for counteracting the negative effects of
transport (such as air pollution, losses of valuable agri-
cultural lands due to appropriation by transport facili-
ties). The territory of the Upper Oka Basin is regional-
ized with respect to types and intensity of the
environmental impact of transport. Specific areas within
the basin could be defined for particular monitoring, for

detailed evaluation and prediction of environmental changes. Figures 3; references: 11 Russian.

UDC 628.39

Evaluating Pollution in Urbanized Areas

[Article by V. M. Khvat and V. M. Moskovkin, All-Union Water Conservation Scientific Research Institute, Kharkov]

[Abstract] The problems involved in reducing the accumulation of finely dispersed solid particles in urbanized areas and formation of the solid phase of surface runoff in such areas are examined. Efforts to solve such problems without a solid theoretical basis are futile. The author proposes a complex balance equation for such pollutants on solid surfaces. The finely dispersed fraction of these substances (up to 100 μm) participating in the formation of the solid phase of surface runoff is considered. Solution of this fundamental equation gives a formula for the stationary (maximal) load level. These formulas serve as basis for deriving a specific semiempirical formula for the conditions prevailing in Kharkov, but analagous formulas can be written for other urban areas. An important formula is also derived for the "specific daily load." Application of this formula is illustrated in several specific examples. Ways to reduce this load are discussed. The specific load formula can serve as a basis for ranking urbanized areas by degree of pollution. References 9: 6 Russian, 3 Western.

Discrimination of Technogenic Areas With Detection of Principal Environmental Pollutants for Safeguarding Public Health

[Article by N. D. Davydova and V. M. Novikov, Geography Institute, Siberian Department, USSR Academy of Sciences, Irkutsk; Earth's Crust Institute, Siberian Department, USSR Academy of Sciences, Irkutsk]

[Abstract] Research was carried out in the region of a large industrial complex (aluminum, wood processing and other enterprises) in the southern taiga of Middle Siberia. During windless periods there are prolonged surface inversions resulting in smog with a strong, unpleasant smell. The degree of pollution by industrial effluent was determined from the quantity of insoluble (dust) and soluble matter accumulating in the snow cover during winter. Samples were taken from the entire depth of the snow cover. Pollutants accumulated in the snow cover for 145 days. Samples were taken on radial

and circular lines over an area of 3500 km² with sampling at 170 points. In all cases the concentration of pollutants in the snow cover decreases sharply at a distance 1.5-2 km from the sources due to the low height of the stacks. The analysis procedures are outlined. It is shown that testing of the snow cover makes it possible to detect the area of environmental pollution with a concentration of chemical substances exceeding their background levels by a factor of 10, 100 or 1000. By an analysis of the effect of snow water on yellow-green algae it is possible from the overall polluted area to discriminate the zone of toxic effect of effluent from industrial plants and to classify its effect with respect to degree of toxicity. Figures 2; references: 14 Russian.

UDC 551.589

Analysis of Fluctuations of Global Climate Using Generalized Langevin Equations

[Article by P. F. Demchenko, Atmospheric Physics Institute, USSR Academy of Sciences]

[Abstract] The theory of stochastic generation of variability of the inertial elements of the Earth's climatic system (such as ocean surface temperature (OST)) by synoptic fluctuations in the atmosphere, such as proposed by Hasselman, is reexamined. Using the projection operators method the theory is modified in such a way that it is possible to compute low-frequency variability in a fast subsystem, such as the atmosphere, caused by interaction with fluctuations of inertial elements, such as OST. First-order corrections are taken into account for a parameter equal to the ratio of the characteristic times for "weather" and "climate." A simple thermodynamic model is used in computing the spectra of fluctuations of mean global surface air temperature. The role of fluctuations of the mean percentage of cloud cover is evaluated. Computations using the model are in satisfactory agreement with empirical data on the year-to-year variability of surface air temperature in the northern hemisphere. Figures 2; references 20: 9 Russian, 11 Western.

UDC 551.463.2

Influence of Intrathermocline Lenses on Acoustic Fields in Ocean

[Article by Yu. P. Lysanov, A. M. Plotkin and G. I. Shapiro, Acoustics Institute, USSR Academy of Sciences; Oceanology Institute, USSR Academy of Sciences]

[Abstract] Intrathermocline lenses (or eddy lenses) are highly stable formations in which pressure anomalies are virtually completely compensated by Coriolis and centrifugal forces. Numerical methods were used to study the influence of these formations on acoustic fields in the ocean. A lens of Mediterranean waters was used as an example. It was found that in the presence of an eddy lens the spatial "zonal structure" of the acoustic field in an underwater sound channel is deformed: the boundaries of convergence zones are displaced and the shadow zones are insonified. In the case of an azonal structure of the acoustic field (the sound source is situated near the axis of the underwater sound channel) the presence of a lens results in a strong shadow zone in the region occupied by the lens and a decrease in the mean level of the acoustic field behind the lens. With an increase in the size of the lens and its contrast the acoustic effects are intensified. Figures 9; references 21: 11 Russian, 10 Western.

Is the Greenhouse Effect Dangerous?

[Article by Academician A. Yanshin]

[Text] As early as 1962 the Soviet climatologist and meterologist and corresponding member of the USSR Academy of Sciences Mikhail Ivanovich Budyko had first published reasons why the combustion of a large amount of different fuels, especially increasing in the second half of the twentieth century, would inevitably lead to the fact that the amount of carbon dioxide in the atmosphere would increase. This, as is well known, prevents the giving off of solar heat from the earth's surface and below it into space, leading to the effect which we observe in glassed-in greenhouses. As a result of the greenhouse effect, the mean temperature of the atmosphere near the surface of the earth should gradually increase.

This new idea was first met with skepticism by many scientists in our country. It was assumed that this process would have only very long-term consequences, and that the excess carbon dioxide in the atmosphere would be rapidly absorbed by the ocean, which actually contains in dissolved form more of this gas than is in the earth's entire atmosphere.

The conclusions reached by M. I. Budyko were of interest to American meteorologists. They checked his calculations and made extensive observations, and towards the end of the sixties they arrived at the firm conclusion that the greenhouse effect in the earth's atmosphere was important and was increasing.

Two decades have passed, and now there is no longer any doubt that this is what is happening. In the first half of the twentieth century the amount of carbon dioxide in the atmosphere near the surface was 0.03

• This figure was made more precise in 1956 during the first International Geophysical Year. According to many hundreds of measurements made far from cities and industrial centers the amount turned out to be 0.028

• A test of the atmosphere in 1985 showed that the carbon dioxide content had increased to 0.034

• This value has now been evaluated at 0.035

• As a result, since 1956 the amount of carbon dioxide in the atmosphere has already increased by a fourth of its initial value. Undoubtedly this has come about by human industrial and transportation activities. Scientists believe that by the middle of the twenty-first century the amount of carbon dioxide in the atmosphere will double, and that this should certainly lead to global warming. This is latitudes. Many climatologists, although not all, assume that the extended hot weather which occurred in the eastern United States, Moscow and the People's Republic of China in 1988, and also the mild winter that followed over all of Europe, as precursors of climatic conditions that will prevail when the greenhouse effect becomes stronger.

The possible results of this warming have been the topic of a large number of articles in newspapers and magazines in recent years, and it is now believed that it threatens serious disaster. This belief became particularly strengthened following the 1987 publication in various world languages of the report of an international commission headed by the Norwegian Prime Minister Gru Harlem Brundtland. The report was published with the title, "Our Common Future," and it said that "it is difficult to find a problem with greater global consequences for humanity and the environment than the greenhouse effect." In May 1988 an international conference in Ottawa appealed to all governments to reduce by the year 2000 the amount of fuels consumed, at least by 20 , and thereby slow the warming process. Now the meteorological services of various countries, including the Soviet Union, have set up an international commission for detailed study of the rate of increase in the greenhouse effect and all of its possible consequences.

In brief, there is great alarm that has arisen. But how valid is it?

In the commission's report, Brundtland expresses the fear that in the coming decades the greenhouse effect will bring about an increase in the level of the ocean from 25 to 140 centimeters, as a result of which "there will be flooding of low-lying cities and agricultural regions, and many countries must consider that their economic, social and political structures may be seriously harmed." These fears came about from the assumption that with the increase in the air temperature the continental ice of the Antarctic and Greenland would melt. However, this assumption cannot be assumed to be valid. As we now know, according to the data from boreholes that have gone through the entire thickness of the Antarctic ice

cover, this ice was formed more than 30 million years ago. As a result, it has already withstood several epochs in the warming of the earth's climate much greater than that expected now from the greenhouse effect, for example, the middle Miocene warming (about 20 million years ago), when the amount of carbon dioxide in the atmosphere approached 0.1

and the mean air temperature was 5-6 deg above the present value, and when in the region of present-day Yakutsk there grew a walnut forest (its fossil fruit has been described by Academician V. N. Sukachev).

Therefore, in the Antarctic as a result of the expected warming there can be an expansion in the area of the Bonger oasis devoid of ice, and there can be an increase in the number of icebergs breaking off from the edge of the ice sheet, but nothing more.

We do not have drilling data for the entire thickness of the ice in the central part of Greenland, as in the Antarctic. However, by analogy we can assume that here as well the ice cover is very ancient, having survived a number of epochs with significant warming. The present-day greenhouse effect can lead only to a retreat in the edge of the Greenland ice sheet which, by the way, is now being observed.

Therefore, the warming associated with the greenhouse effect will not be accompanied by significant melting of the Antarctic and Greenland ice, and does not threaten a sharp increase in the sea level. The latter may vary only by several centimeters, which does not represent a serious danger.

An international congress of climatologists held in October 1985 in Fillach (Austria) was devoted to an analysis of the possible climatic consequences of the greenhouse effect. The participants at the congress concluded that even a small climatic warming would lead to a significant increase in evaporation from the surface of the oceans, thereby increasing the amount of winter and summer precipitation over the continents. This increase would not be uniform. It was calculated that a band would extend across southern Europe from Spain to the Ukraine within which the amount of precipitation would remain the same as now or even decrease somewhat. North of 50 deg (the latitude of Kharkov), both in Europe and also in America, it would gradually increase with fluctuations, which we have now observed over the past decade. As a result, the Volga runoff will increase, and a reduction in the level of the Caspian Sea is not threatened. This was the main scientific argument which finally made it possible to renounce the project to redirect part of the runoff of the northern rivers into the Volga. Would that urgent measures be taken now to stop the draining of polluted industrial runoff into the Volga and its tributaries....

The most exact and convincing data concerning the possible consequences of the greenhouse effect is provided by paleogeographic reconstructions done by specialists studying the geological history of the earth for the past million years. During this "most recent" time in geological history, the earth's climate underwent sharp global changes. In epochs colder than the present-day, continental ice similar to that which now locks in the Antarctic and Greenland covered all of Canada and the entire north of Europe, including where Moscow and Kiev are now. Herds of northern reindeer and woolly mammoths roamed over the tundras of the Crimea and north Caucasus, where the remains of their skeletons are now found. And in the intermediate interglacial periods the earth's climate was much warmer than the present: the continental ice melted in North America and Europe, in Siberia the permafrost thawed out for many meters, the sea ice along our northern shores disappeared, and forest vegetation, judging by fossil spore-dust spectra, spread over the territory of the present-day tundra. Strong rivers flowed over the Central Asian plains, filling the Aral Sea basin with water to the plus 72-meter mark, and many of them brought water even to the Caspian Sea. The Karakum Desert in Turkmenia is the blown sand deposits of these ancient river beds.

On the whole, the physical and geographic circumstances in the warm interglacial epochs over the entire USSR were more favorable than now. It was the same in the Scandinavian countries and in Central Europe.

Is it possible that the global warming epochs, which were undoubtedly favorable for the USSR's territory, brought about difficult conditions in countries in other climatic belts? Evidently, also not so!

In the very center of the Sahara, in the southeast corner of its Algerian part, there rises the large Akhaggar mass whose peaks up to 3000 m high represent recently extinct volcanoes. In the ravines of this mass there are preserved long stretches of water which do not dry up, well known to the local Tuareg inhabitants, where they bring herds of camels for watering. However, it is little-known that in these stretches there live crocodiles of the same type which live in the Niger River, only smaller because of scanty food. Here they are no longer than 1.5 m in length. Space imagery clearly shows dry river beds half-filled with sand which stretch from the ravines of the Akhaggar mass to the southwest to a meander in the Niger River.

This means that relatively recently rivers flowed over the now-desert Sahara. Help in solving the question as to when this was is provided by the Tassili sand frescoes cut out of the sandstone ridges surrounding the Akhaggar mass.

These frescoes were produced at different times: the youngest are about 4 thousand years ago, at the era of the first dynasties for the Egyptian pharaohs, and the most ancient are at the time of the late paleolithic, which is indicated by both the style of the images as well as the well-polished stone implements of that era found around them. These ancient frescoes portray elephants, giraffes, hippopotamuses and various antelopes, along with hunting scenes. The epoch of the late paleolithic,

based on radiocarbon dating, is 40-45 thousand years ago, and corresponds to the last interglacial, when the earth's climate was much warmer than it is now.

Therefore, during this climate warming the Sahara received much more precipitation than now, and was not a desert but a savannah with rivers and a plentiful fauna of herbivorous creatures. It is likely that the greenhouse effect threatens the Sahara now only by alterations such as these.

All these considerations ultimately are necessary for discussion and careful comprehensive testing. Unfortunately, geologists who study the geological history of the past million years for the evolution of our planet have not yet been brought into the discussion of this problem. And yet, geologists could make a valuable addition to our existing concepts. In particular, it is clear that broader use must be made of paleographic data on past epochs of strong global climate warming in order to correctly evaluate the possible consequences of the greenhouse effect. Analysis of these data, which are known today, permits us to think that the greenhouse effect, in contrast to widespread opinion, will not bring on any disasters to the peoples of our planet. On the contrary, for many countries including the USSR it will produce climate conditions that are more favorable than those today.

Winter—Hot or Cold?

907n0073b Moscow NAUKA I ZHIZN in Russian No 12, Dec 89 pp 87-89

[Article by Candidate of Geological Sciences L. Klimenko]

[Text] Winter scenes of everyday life in Holland in the seventeenth century portrayed on many canvases by Flemish artists are one of the graphic proofs for the existence of a present-day climatic warming.

The end of the sixteenth, the seventeenth and eighteenth centuries, and the beginning of the nineteenth century was a period of climatic cooling in Europe, and it is even called the "little ice age." Each year the Danish straits froze over. Regular crossing on the ice was established between Denmark and Sweden.

On the canvases of the Flemish artists townspeople of all ages skate easily and effortlessly over a frozen pond, fish are loaded from long boats onto sleighs, and hunters stride over a snowy plain....

Nothing like this is seen in Holland today. In January the average air temperature here is plus 4 deg C.

Yet recall Pushkin: "...that our northern summer is a caricature of southern winters, a flash and it's gone...". Actually, weather documents indicate that the average temperature in June of 1822 in Moscow was 12.9 deg C and 14.1 deg C in June of 1824. The present norm for June is 15.8 deg C.

Since approximately the middle of the past century climate has become noticeably changeable. Global warming has encompassed a large part of the earth, and has appeared especially clearly in the northern hemisphere.

The warming has occurred nonuniformly: first it weakens, then it strengthens. The greatest warming has been noted at the end of the thirties and the beginning of the forties. Then there came a temporary abatement, but the trend toward warming has been maintained up to the present. Specialists believe that over a century the temperature in the northern hemisphere has increased by about 0.5 deg.

The reason for the global warming of the planet, according to the belief that is now widely held, is related mainly to the fact that the amount of carbon dioxide in the atmosphere is increasing, the result of increasing human economic activity.

The global warming is a general trend. Yet even so there are not uncommonly cold and even very cold winters. What is this related to? It is of interest to trace and analyze the reasons for the temperature changes for individual large regions according to the seasons. For example, what are the actual reasons for the increase in the number of warm winters for the European part of the USSR?

In our middle latitudes the main factor involved in shaping the climate is the nature of the atmospheric circulation. Research and observations carried out by the author make it possible to say that on the European part of the USSR the greatest coolings in the winter (December to February) are brought about by anticyclones arriving from the northwest, the north and the northeast. They bring in ocean or continental arctic air. The air temperature for the time until a anticyclone evolves, and this is usually 5 to 7 days, is lowered on the average by 4 to 5 deg for northern entries of the anticyclone, and by 2 to 3 deg for northwest and northeast entries. For individual cases there is a cooling by 10, 15 or 20 deg relative to the norm. The intrusion of a cyclone during the winter usually brings warming. Warm air is carried out to the European territory of the USSR either from the south, from the Black Sea area, or from the southwest, from the Mediterranean Sea, or from the west, from the Atlantic Ocean. In this case the air temperature as a rule is increased by 2 to 4 deg as compared with the norm for a given location. In certain cases the increase is 10 to 12 deg. (tab) For the research we took the 90-year period from 1891 to 1980. The calculations showed that the mean recurrence over many years of anticyclones in the overall series of winter synoptic processes is 35%, and for cyclonic processes it is 39%. The remaining 26% are processes where both increases and decreases in the temperature are possible.

These figures are the mean recurrence of synoptic processes over many years. But within this 90-year period there are rather large fluctuations. In the first 45 years the recurrence of anticyclonic processes is 41%, i.e., 6 % greater than the mean over many years, while in the second 45-year period it is only 30%, 5% less. For cyclones, on the other hand, in the first interval it is 8% less than the mean over many years, and in the second it is 7% less.

It is natural that a decrease in the recurrence of a group of anticyclonic processes by 11% and an increase in the recurrence of a group of cyclonic processes by 15% could not help but have an effect on the winter meteorological regime on the European part of the country—the number of warm winters has increased.

According to a catalog of winter temperatures, depending on the mean temperature seasons are said to be normal, warm, cold, very warm or very cold. If the anomalous temperature of a season exceeds the norm by one and a half, the season is called warm or cold depending on the sign of the deviation. If the norm is exceeded by a factor of two, the season is called very warm or very cold.

It is of interest that the number of cold and very cold winters in both 45-year periods is practically the same, but the number of warm winters in the second interval is much greater than in the first.

And so, a nearly 100-year period has been analyzed. The overall number of warm winters clearly indicates that the global warming process, at least in the winter, is continuing on the European territory of the USSR. The trend for the number of warm winters to dominate over cold ones has been maintained both for Moscow as well as for the entire European territory of the USSR.

References

1. Vinnikov, K. Ya., et al. Changes in the mean temperature for the northern hemisphere for 1841-1965. Meteorologiya i Gidrologiya, No. 1, 1987.

2. Klimat Moskvy (Moscow Climate). Ed. by A. A. Dmitriyev. Leningrad, Gidrometeoizdat, 1969.

3. Klimenko, L. V. Is the warming period over for Moscow? Vestnik MGU, Ser. 5, Geografiya, No. 1, 1985.

4. Klimenko, L. V. Seasonal recurrence and thermal features of typical synoptic processes. Vestnik MGU, Ser. 5, Geografiya, No. 2, 1985.

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